MARINE REVIEW.

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A Yacht Engine of New Design.

(From the Iron Age, New York.)

All the main features of a yacht engine designed by C. F. Littlejohn of Bridgeport, Conn., are illustrated by the accompanying engravings. It may be said to be a wide departure from the usual forms or types of marine engines now in service. The engine is a compound tandem having a high pressure cylinder 3¾ inches in diameter, a low pressure 6 inches in diameter, and a stroke of 6 inches, and drives a propeller 30 inches in diameter and 54 inches pitch, at 170 revolutions per minute, giving a speed to the boat in which it is placed of from 7 to 8 miles per hour. Steam is supplied by a Foster serpentine steam generator, built by Charles W. Foster of New Haven, Conn. The engine is placed in a boat having a length over all of 30 feet, length on water line of 25 feet, beam of 7½ feet and draught forward of 1½ feet and aft of 3½ feet. The general arrangement of boat and the position of the engine and boiler are clearly shown in cross section and vertical longitudinal section, Fig. 4. The engine is about 4 feet long, 3½ feet wide at its widest part, and at no place does any part of it come above the floor of the boat.

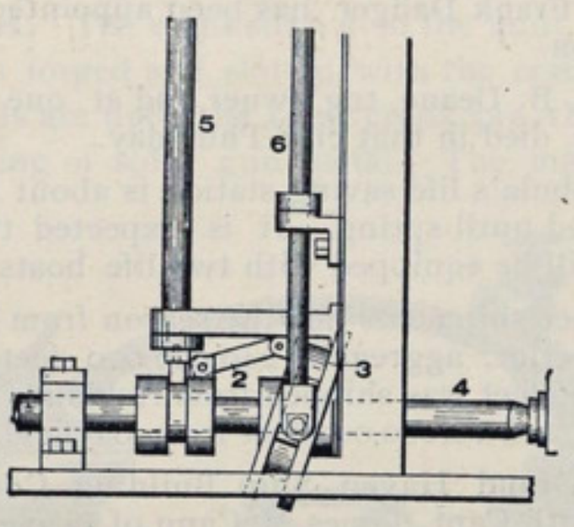


Fig. 6.—Valve Gear.

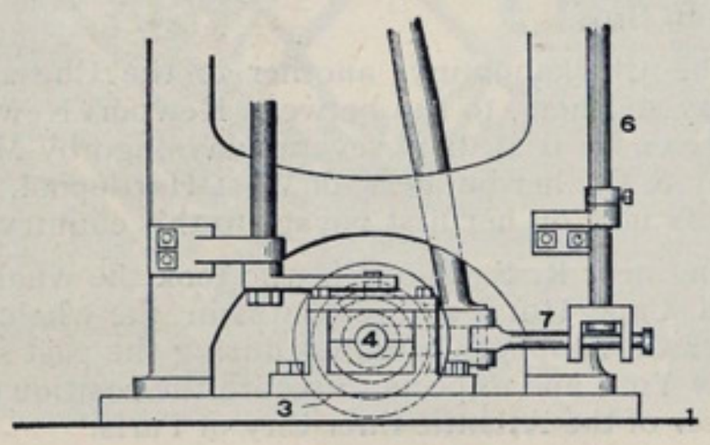


Fig. 7.—Valve Gear—View at Right Angles to Fig. 6.

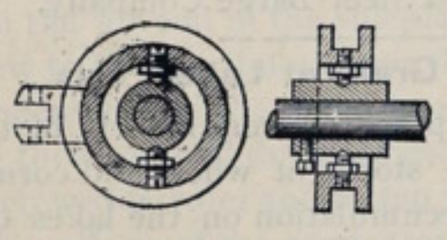


Fig. 5.—Grooved Ring Operating Valves.

The main peculiarities of the engine are found in the method of transmitting power from the piston rod to the propeller shaft, and in the valve gear. It will be noticed from the perspective view and from Fig. 2 (the plan) that the propeller shaft is placed parallel with and alongside of the piston rod. The power is applied to the central point of a set of toggle levers by means of the sliding cross head, having a transverse slide in it to accommodate the sweep of one of the levers, which is fulcrumed to a stationary stud or pin. The outer end of the other lever is fulcrumed to a pin in an auxiliary cross head, which supplies the power to the crank by means of a connecting rod made in the usual way. This mechanism will be understood by reference to Figs. 1 and 2, showing the engine in plan and side elevation. E and F represent the high and low pressure cylinders respectively, G being the steam chest. To the piston rod I is attached the cross head J, to which the two connecting levers K L of the toggle are connected in such a way that they have a free sliding movement in the cross head, and, therefore, in no way interfere, with the travel of the piston-rod in a straight line. The rod K is fulcrumed to the bed A of the engine at the point shown. The other lever L of the toggle is pinned at Q to the auxiliary cross head R, which is arranged to move in the guide S. To this cross head is united the connecting rod T, which joins the crank pin D and drives the propeller shaft B in the usual way. It will be noted that all parts of the engine are mounted on the bed A

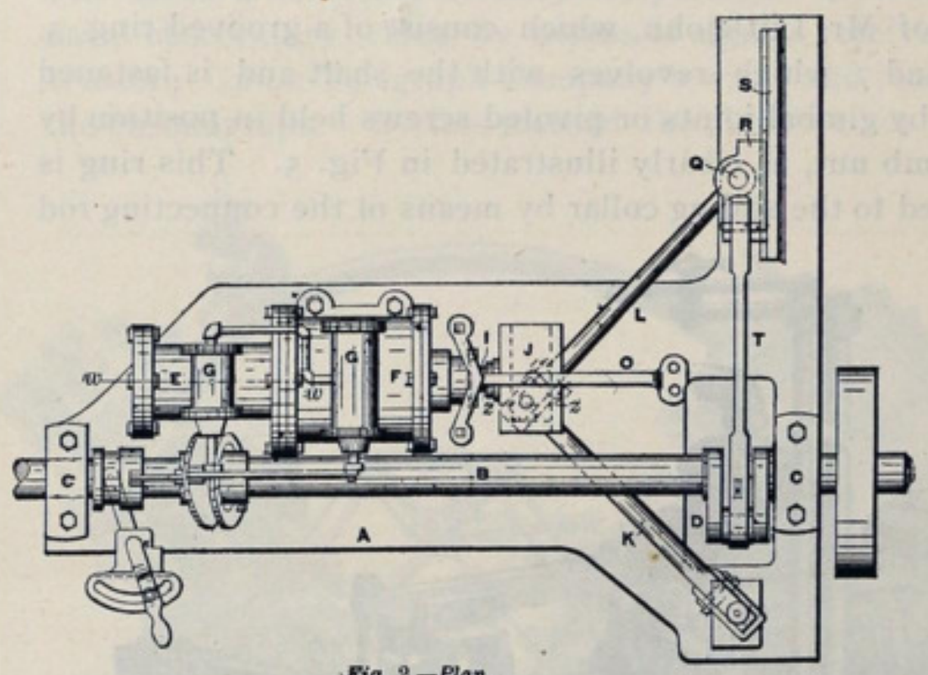


Fig. 2.—Plan.

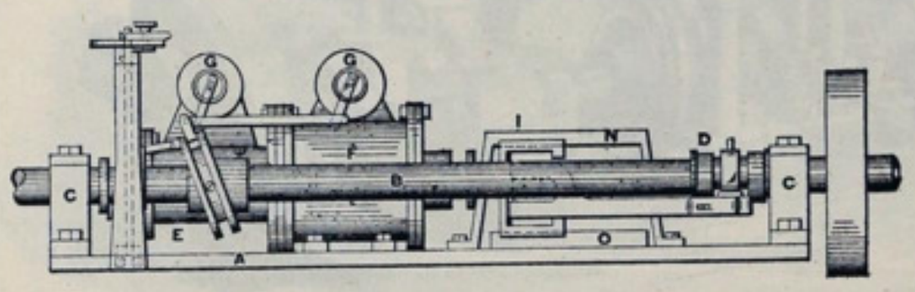


Fig. 3.—Side Elevation.

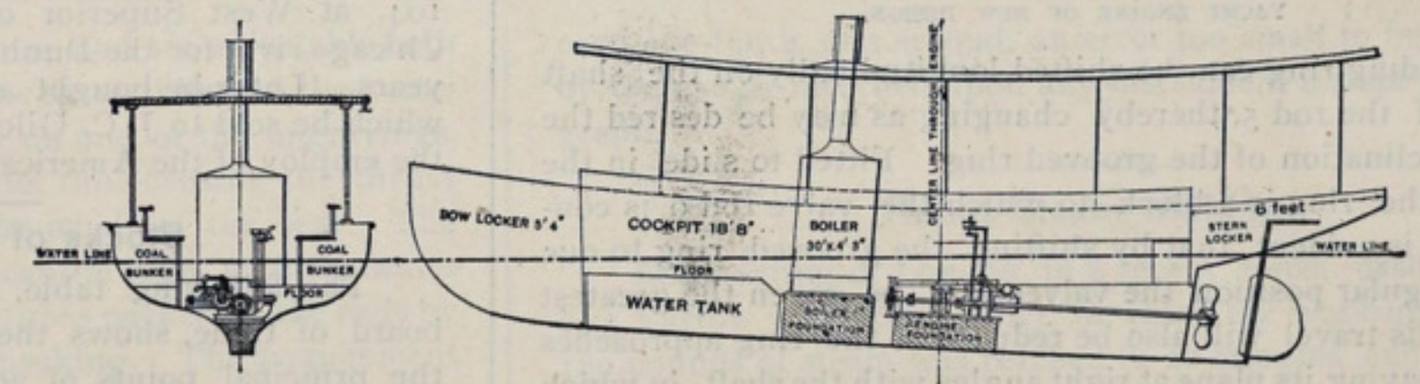
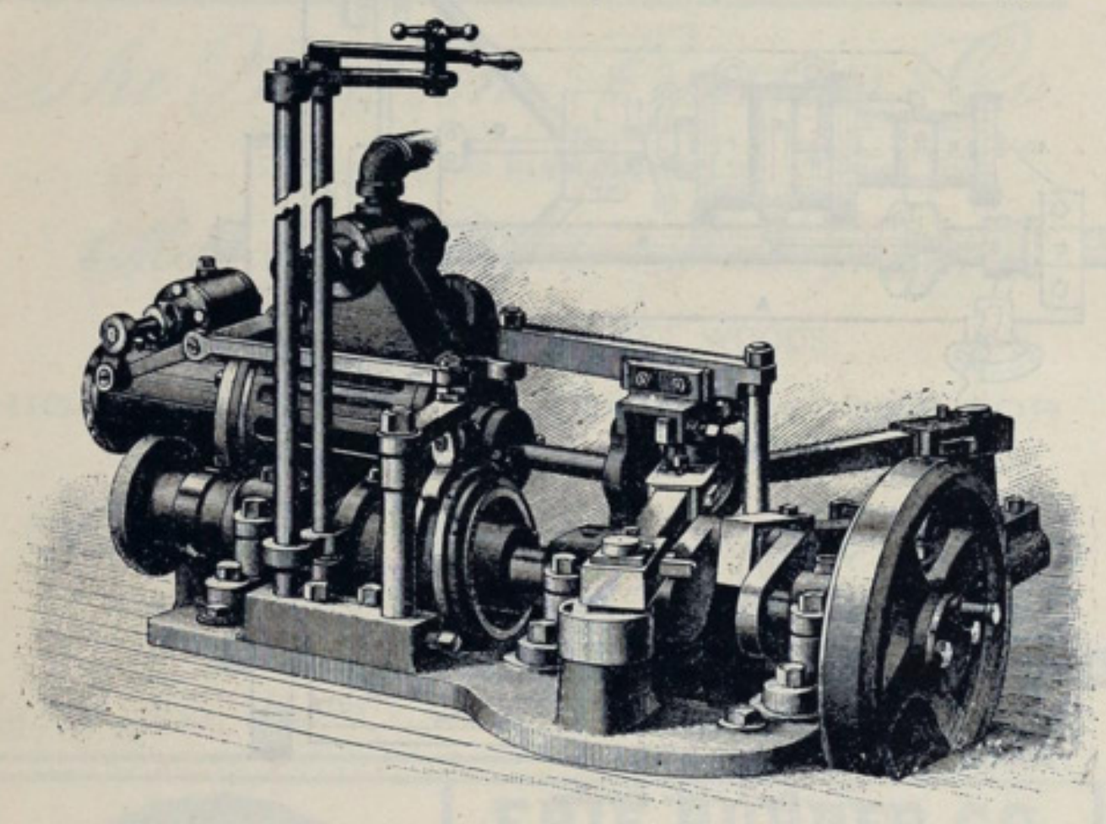


Fig. 4.—Cross and Longitudinal Section of Steam Yacht.

no frame of any description being employed, which fact, together with the general design and arrangement of the parts, make the engine extremely compact and of very low height.

A notable feature in the working of the engine is the almost total absence of vibration even when running at its highest speed. This is accounted for by the fact that the heaviest reciprocating parts, the pistons and piston rod connections, move in a line parallel with the keel, the only cross vibrations being those arising from the movement of the auxiliary cross head and its connections with the crank. So far the engine has given no trouble whatever and has performed its work with absolutely no hitch. Being the first one of this design, there are naturally several points where the construction could be improved and which would add materially to the efficiency.

The valve gear is shown in the first three views, and its construction and method of operation will be understood from Figs. 5, 6 and 7, the latter drawings not being taken from this particular yacht engine, but being taken from a former construction of a vertical engine embodying the same features. The valves of both cylinders are worked by the valve gear, also the invention of Mr. Littlejohn, which consist of a grooved ring, 3, Figs. 5, 6 and 7, which revolves with the shaft and is fastened to the hub by gimbal joints or pivoted screws held in position by nut and jamb nut, as clearly illustrated in Fig. 5. This ring is also fastened to the sliding collar by means of the connecting rod



YACHT ENGINE OF NEW DESIGN.

2. This sliding ring can be shifted longitudinally on the shaft by means of the rod 5, thereby changing as may be desired the angle of inclination of the grooved ring. Fitted to slide in the groove of the ring is a block to which the valve rod 6 is connected. It is evident that by shifting the grooved ring to one extreme angular position the valves will be given the greatest travel. This travel will also be reduced as the ring approaches a position having its plane at right angles with the shaft, in which latter position there will, of course, be no movement of the valve. Continuing to shift the ring in the opposite direction, the valves will be given their greatest movement when the greatest angle of inclination is reached and the engine reverses its movement. In the yacht engine shown in perspective view the grooved ring is operated by means of a lever, the connecting rod of which is shown broken. A noteworthy feature of this design is its extreme sensitiveness; the slightest movement of the lever which shifts the sleeve on the shaft, and thereby alters the angle of inclination of the grooved ring, is instantly perceptible in the working of the engine.

Another adaptation of this method of moving the valves is found in the fact that the valve rods from four different valves can be connected in four different places in the grooved ring, and that each valve will have its proper movement independent of either of the others. This would permit in this engine of placing two more cylinders tandem fashion parallel with the two it now has and operating them by means of the same valve gear. Therefore the only additional parts, in order to transform this engine into a quadruple expansion would be in adding two more cylinders and their connections with the crank. These points in the opinion of the inventor, will greatly reduce the cost of such engine as compared with the usual construction, and by doing away with all framing render the engine stiffer and wonderfully more compact. Adding two more cylinders to this engine in order to make it a quadruple expansion would increase its size to only 6 feet square, but would not increase the height of 18 inches at all, so that it would be entirely below the deck of the boat and also below the water line.

It will further be seen that by slight changes in the design the engine can be adapted for manufacturing purposes, and can be made either of the vertical or horizontal type.

Around the Lakes.

Capt. Frank Danger has been appointed local inspector at Port Huron.

W. H. B. Deane, tug owner and at one time harbor master of Chicago, died in that city Thursday.

Ashtabula's life saving station is about finished but will not be equipped until spring. It is expected that all of the lake stations will be equipped with two life boats next season.

Lumber shipments for the season from Chequamegon bay, Lake Superior, aggregate 240,000,000 feet, of which amount 155,000,000 feet was shipped from Ashland, 75,000,000 feet from Washburn and 10,000,000 feet from Bayfield.

The Grand Haven Ship Building Company has closed a contract with Capt. James McCann of Beaver island for a tug 75 feet over all, 15 feet beam and 6½ feet deep. The engine, 14x16 will be built by Bloecker & Co., and the boiler, 5½x11 feet, by Johnston Bros.

The Chickahominy, another of the Chesapeake and Ohio Railway steamers, to run between Newport News and Liverpool, was given a trial trip several days ago by Messrs. Furness, Withey & Co.,her builders, of West Hartlepool, England, and is probably now on her first voyage to this country.

Engineer R. S. Blauvelt, who took the whaleback Wetmore around Cape Horn, and who was in the whaleback passenger steamer Christopher Columbus during the past season, has gone to New York and expects to secure the position of first assistant engineer of the Atlantic liner City of Paris.

Capt. W. Griffin, who was killed aboard his boat, whaleback 104, at West Superior on Monday, commanded tugs on the Chicago river for the Dunham Towing Company for about twenty years. Later he bought and sailed the schooner R. B. Hayes, which he sold to J. C. Gilchrist last spring, before entering the the employ of the American Steel Barge Company.

Stocks of Grain at Lake Ports.

The following table, prepared from reports of the Chicago board of trade, shows the stocks of wheat and corn in store at the principal points of accumulation on the lakes on Nov. 25, 1893:

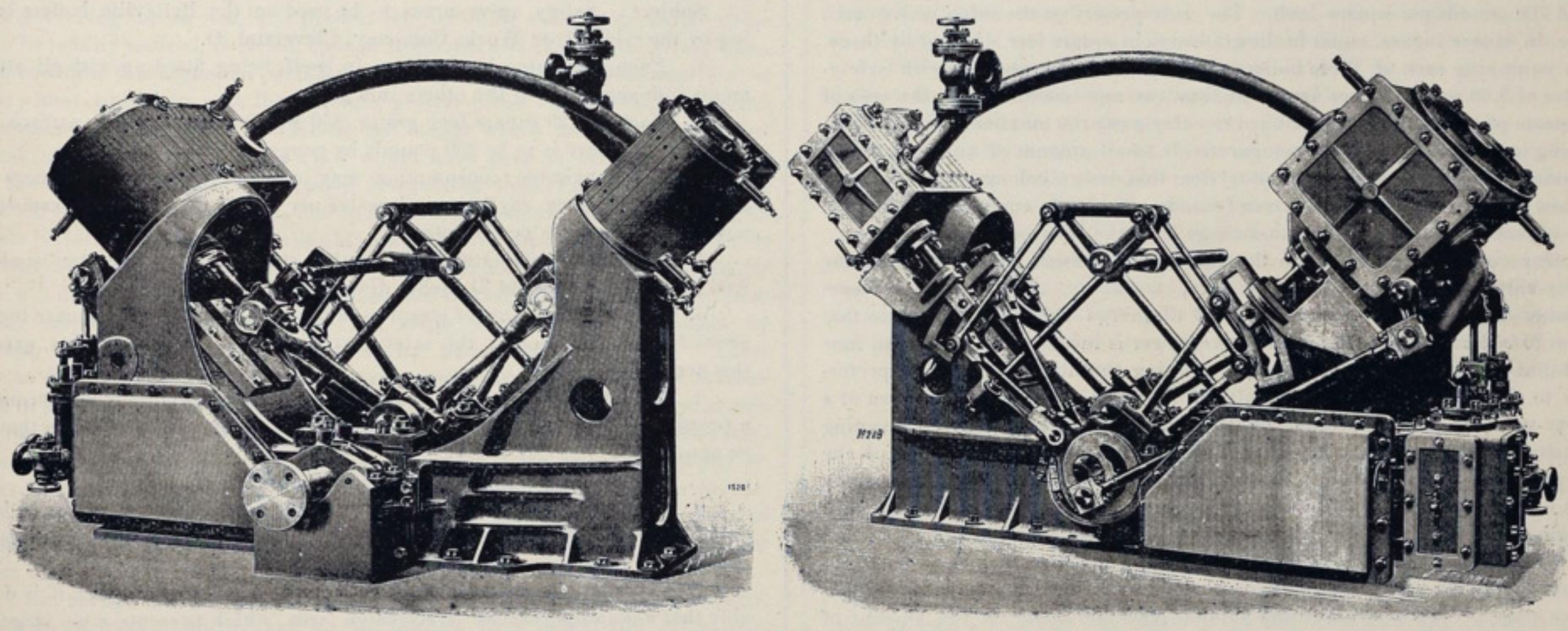
	Wheat, bu.	Corn, bu.
Chicago	19,381,000	1,329,000
Duluth	8,488,000	.....
Milwaukee	839,000	.....
Detroit	1,345,000	6,000
Toledo	2,275,000	331,000
Buffalo	2,571,000	718,000
Total	34,899,000	2,384,000

At the points named there is a net increase for the week of 870,000 bushels of wheat and a net decrease of 182,000 bushels of corn.

Inclined Engines for Small Passenger Vessels.

Illustrations on this page represent the engines of a small passenger steamer recently constructed in Scotland for service on the Forth and Clyde canal. The boat, which is 63 feet long between perpendiculars with a beam of 14 feet and a draft of 4 feet, is very much like the numerous small wooden passenger steamers of similar dimensions in use throughout the lakes, and on this account a description of the engines, which were built by Messrs Hall, Brown Euttery & Co. of Govan, Glasgow, will prove interesting. The machinery, which is placed amidships, only occupies 11 feet 8 inches of the length of the vessel, the remainder being occupied by two cabins of good proportion. The passenger accommodation (231) is therefore very extensive for the size of the vessel.

The engines are diagonal of the compound surface-condensing type. The cylinders are 8 inches and 16 inches in diameter, with a stroke of 12 inches. The diagonal type was adopted because of the saving in fore and aft space, and the low center of gravity obtainable. All the bearings throughout the engines are of ample proportions. The crankshaft is of the built type, having balance weights forged and slotted with the crank checks. Both connecting rods are upon the same crank pin, the connecting rod bushes being of solid gun metal. The main bearing bushes are of cast iron lined with bronze, and are adjustable both horizontally and vertically. A separate thrust-block of the horseshoe type is provided, and, as shown on one of the engravings, is bolted to the aft end of the soleplate, thus causing the thrust of the screw to be distributed over the whole of the seat. The surface condenser is of the usual mercantile type, with the water circulating through solid drawn brass tubes packed at the ends by means of screwed ferrules and cotton packing. The arrangement of the engine allows of the condenser being placed under the low pressure guide, so that a very short copper exhaust pipe serves to convey the steam from the cylinder to the condenser. The air, circulating, feed, and bilge pumps are placed at the back of the condenser, and are worked on a rocking shaft and levers operated, as shown on the engraving, by a link from a pin in the eccentric pulley. From the illustration it will be noted that the engine does not take up any more space than would be occupied by a non-condensing engine of the same type, and very much less fore and aft space than would be occupied by a vertical compound engine. The reversing gear is of the ordinary link motion type, one pair of eccentrics serving for both cylinders. A large donkey engine is provided for pumping out the bilge, washing decks and feeding the boiler. The boiler, which works at a pressure of 100 pounds per square inch, is of the vertical type.



DIAGONAL COMPOUND SURFACE-CONDENSING ENGINES FOR SMALL PASSENGER STEAMER.

Time Ball Service at Chicago.

George P. Blow, U. S. N., in charge of the branch hydrographic office at Chicago, announces that a complete time ball service has been successfully installed on the top of the Masonic Temple in that city. The outfit was designed, built and installed under the personal smpervision of Professor Gardner of the United States naval observatory, the inventor and originator of the naval observatory time service, and is considered the most complete and perfect in use anywhere in the world. The ball which is 4 feet 6 inches in diameter, is dropped from the top of a galvanized hollow steel mast, 30 feet above the dome of the building, and 332 feet above the ground, and can be seen with a glass from a distance of ten miles. The precision clocks, break-circuit chronometer, transmitting clocks, chronograph and electric key boards and batteries are all located in the United States branch hydrographic office on the sixteenth floor of the building, and are operated by the officer in charge. The ball is dropped precisely at noon, central time, (90th meridian) by an electric current controlled by a standard transmitting clock. The clock is corrected by daily comparisons with the standard naval observatory clock, by means of signals received over the Western Union Telegraph Company's wires and recorded upon the chronograph. By this method the clock's error will not exceed one-tenth of a second, an error too small to be appreciated by the eye or recorded upon any instrument except the chronograph.

Rapid Steam Making.

Engineering of London, in a recent issue, describes a test of a Yarrow water tube boiler, in which the working pressure of 180 pounds of steam was reached in 22 minutes and 20 seconds after a match was put to the fire. The weight of the boiler, with water and all fittings, is 5 tons 7 cwt., and the makers have found, by previous tests, that it will evaporate 12,500 pounds of water per hour. With 16 pounds of water per indicated horse power per hour, which Mr. Yarrow takes as ordinary torpedo-boat practice, the power obtained by means of such a boiler would be 781 indicated horse power. The heating surface is 1027 feet, and the bar surface 20.6 square feet. The bars are 6 feet 6 inches long. In the Havock, a torpedo destroyer, there are two locomotive boilers, the weight of which, with water and fittings, is fifty-four tons, and the Havock's machinery developed 3400 indicated horse power on trial. The eight water-tube boilers of the Hornet, another destroyer, will weigh with water and fittings, forty-three tons.

Safety-Valve Area for Water Tube Boilers.

It has been known for some time that in the matter of safety-valve area for the Belleville tubulous generators, with which the new passenger steamers of the Northern Steamship Company will be equipped, the builders have met with an obstacle in the rules of the United States steamboat inspection service, although it was not intended to direct public attention to the subject until it would be brought up at a regular meeting of the board of supervising inspectors. But in a paper relative to the steamboat inspection service, read at the inaugural meeting of the new Society of Naval Architects and Marine Engineers in New York several days ago, Mr. James T. Boyd of the George F. Blake Manufacturing Company referred to the correspondence between the inspectors and the builders of the Belleville generators, and the following letter will accordingly prove interesting to all manufacturers of tubulous boilers:

To the United States Inspectors of Steam Vessels:

GENTLEMEN: The Globe Iron Works Company, Cleveland. O., of which Mr. John F. Pankhurst is the vice-president and general manager, has under construction what are known as Belleville boilers; these are to furnish about 7,000 horse power for each of the two steamships also under construction at these works. The boiler power in each vessel consists of twenty-eight generators in three groups (two of ten and one of eight generators) with athwartship bulkheads between and at the ends of the groups. Three smoke-pipes are used and the natural draught is supplemented by fan blowers delivering into the open fire rooms. Each generator or boiler is independent of all the others in its group having its own check-valve, water-guage column, stop-valve and safety-valve.

We desire to call your attention to the latter attachment, whose area is proportioned by a rule never expected to deal with an internal pressure beyond 120 pounds per square inch. The rule prescribes the safety-valve area to be, in square inches, equal to the grate area in square feet, divided by three, thus equipping each of these boilers of 29 square feet grate area with safety-valves of 9.66 square inches area or at least two and one-half times the area of the steam pipe, which is proportioned to carry away the maximum evaporation. Taking into consideration the comparatively small amount of water contained in water tube boilers, and to which system this design belongs, such an area opened suddenly would in seventeen seconds completely empty the generator, and expose the heating surface to damage from the furnace heat.

Our complaint arises from the fact of the present rule prescribing the safety-valve area from the grate area, taking no account of the steam pressure which is the prime factor of discharge volume. It is plain that under forced combustion the evaporative power is increased to more than four fold that obtained by natural draught, showing that the evaporation is preferable to the grate area in a formula of accuracy. The prime function of a safety-valve is well expressed by its descriptive title of "safety," meaning security against damage or explosion by over-pressure from the action of the fire upon its heating surface. This security is provided for by giving such an area to the valve that it will discharge a volume of steam which shall equal in weight the maximum evaporative power of the boiler. As the amount of that discha ge is directly as the internal pressure of the boiler, it needs no argument to establish that pressure, as one factor in a formula to decide the proper valve area. It is also evident that another principal factor is the amount of steam that can be made under the maximum furnace heat. Consideration must next be given to the time element, for the area must be so proportioned that the discharge shall exceed in a degree the evaporative power, but this excess must not be so great as to sudddenly empty the boiler, else the safety-valve action intended to prevent explosion might create the very disaster it should prevent.

As we have stated above, the area by the rule would, at 250 pounds pressure, empty these boilers in seventeen seconds. This is an explosive effect; besides the dry heating surface that might be exposed would surely be damaged by the furnace heat, as no fire could be hauled inside of three minutes. This fact presents a time factor seemingly desirable. Assuming the time limit to be three minutes—and further on we show this to be the time limit for Scotch boilers using 170 pounds pressure under your rule at the present time—and recognizing the fact that the discharge of steam in pounds per square inch per minute, at any pressure, is about three times the guage pressure in pounds per square inch then let

E = maximum evaporation per minute in pounds,
W = total water in boiler in pounds,
P = guage pressure in pounds per square inch,
A = area of safety-valve in square inches.

Then $A = \frac{E + \frac{1}{3} W}{3 P} = \frac{(\text{evaporation} = \text{feed}) + \frac{1}{3} \text{ water in boiler}}{\text{Discharge per square inch.}}$

First Example.—A Belleville boiler of 30 square feet grate contains 2,100 pounds of water, and will evaporate 100 pounds of water per minute, pressure 250 pounds by guage. The present rule calls for 10 square inches valve area and at 250 pounds pressure this area will discharge 7,800 pounds of steam per minute, or at the rate of emptying the boiler in seventeen seconds. This is about the time required for an explosion to empty a Scotch boiler described in this

Second Example.—A Scotch boiler recently built by the Globe Iron Works Company for a lake steamer has 60 square feet of grates, contains 30,000 pounds water and evaporates 200 pounds of water per minute; steam pressure 170 pounds by guage, and safety-valve area by present rule 20 square inches. At 170 pounds pressure this area will discharge 10,200 pounds of steam per minute, or at a rate to empty the boiler in three minutes. It is therefore evident that the formula above given will place water tube boilers, in relation to their contained water, as the rule at present provides for the Scotch type.

The safety-valve area under the above given formula for the Belleville boilers under consideration would be thus: From 29 square feet grate area we have say 100 pounds per minute normal evaporation; then let

E=200 pounds per minute forced combustion,
P=250 pounds internal pressure to be allowed,
W=2,100 pounds water in boiler, and we have

$\frac{200 + \frac{1}{3} W = 700}{3 \times 250 = 750} = \frac{900}{750} = 1.2$ area of valve.

In conclusion we ask your honorable board to take into consideration at an early period the matter of safety-valve area for the above mentioned Belleville boilers, which find themselves today in an advanced position from an engineering view, through the designed use of 250 pounds pressure, presenting a strong case to you, in the public interest of safety, to provide a change or amendment to the present rule which shall embrace the newer designs of boilers, to which the Belleville type belongs.

(Signed) JOHN F. PANKHURST,
Vice-Pres. and Gen'l Manager.
MIERS CORYELL,
Supt. of Construction.

CLEVELAND, O., Oct. 27, 1893.

The appended data gives details not included in the letter to the board of supervising inspectors:

Subject: Safety valve areas to be used on the Belleville boilers building by the Globe Iron Works Company, Cleveland, O.

1. Each generator is complete in itself, being fitted up with all attachments independently of the others in a group.

2. Each has 29 square feet grates, 850 square feet heating surface and the steam pressure is to be 250 pounds by gauge.

3. The maximum consumption may reach 20 pounds per square foot grates, the efficiency, say 10 pounds water per pound of coal, and evaporative power 96.667 pounds per minute.

4. The safety-valve area by inspection rule for this generator would be 9.66 square inches, about 3½ inches diameter.

5. The designed area of steam pipe for each generator is 4 square inches, about 2¼ inches diameter; the safety-valve area by inspection rule exceeds this area 2.415 times.

6. An opening of 1 square inch will discharge 780 pounds per minute at a pressure of 250 pounds by gauge, or eight times the weight of steam that can be generated.

7. The facts stated above present the following arguments:

A.—A revision of the inspection rule governing safety valve area is desirable, because in this case it exceeds the steam pipe area 2.4 times, instead of being equal to only one-fourth of that area.

B.—As tubulous boilers contain but comparatively little water, it is desirable that a disproportionate safety-valve area which presents a too large discharging capacity should be avoided. The objection applies not in the danger of explosion, but in the damage that would surely occur to the heating surface by the absence of water. In other words, the excessive area opened suddenly by the safety-valve would carry away both steam and water.

C.—To demonstrate this (B.) a 3½ inches diameter of valve under a pressure of 250 pounds would in one-third of a minute discharge enough steam to equal in weight the total of water and steam in the generator; while:

D.—A valve 1⅛ inches diameter under 250 pounds pressurs, would require 3 minutes, which will give entire security against over pressure, under the control of a safety-valve of this dimension.

Inventions of a Marine Nature.

Specially reported from the patent office, Washington, D. C., for the MARINE REVIEW.

508,935—Ships windlass self register, by Seth S. Gerry of Thomaston, Me.; filed March 14, 1892.

508,973—Signalling lantern for vessels, by Ernest H. L. Peterson of Hamburg, Germany; filed May 11, 1893.

509,133—Propelling mechanism for boats, by John R. Mahoney of Sisterville, W. Va.; filed April 28, 1893.

509,204—Propeller, by Martin Davies of Jersey City, N. J.; filed April 25, 1893.

Copies of specifications accompanying these patents can be had at 15 cents each upon application to the MARINE REVIEW, 516 Perry-Payne building Cleveland, O.

U. S. Treasury Rules for Inspection of Machinery and Boilers.

Editor MARINE REVIEW: A paper with the above title by Mr. James T. Boyd was read before the Society of Naval Architects and Marine Engineers in New York on the 16th inst. Mr. Boyd's professional standing attaches importance to his essay, especially at this time when engineering construction has passed beyond the grasp of the rules of inspection now in force. With the essentials "efficient inspectors, rules and inspection" Mr. Boyd proceeds to the appointment of inspectors. He proposes a board to consist of a supervising inspector general, one engineer of the United States navy, to be designated by the engineer in chief, one engineer of the United States revenue marine service and the supervising inspectors of the districts.

Now this is not good advice. The navy and the revenue marine should have no place on this appointing board. Just why Mr. Boyd finds it necessary to displace our present efficient inspection service is explained by his assuming that the officers are inefficient, but such is not the case. They are wonderfully efficient considering the rules and regulations under which they must conduct inspections. None are more desirous of having the rules made to contorm to existing conditions regarding engine and boiler construction than these very inspectors whom he would have displaced. Where is the necessity of introducing navy engineers in our inspection service? Their training as United States officers completely unfits them for the place. Such training as they receive produces exactly the opposite of a desirable advisor for the merchant service, and moreover they have sufficient occupation, mentally and physically, at all times in their own service. I would consider it a most unwise policy to make a sweeping change in the personnel of our inspection service. The weakness of the suggestion is the excuse to bring in navy engineers as a make-weight argument. It would also be unwise to make a new law governing the service. The present law, aided by a little legislation which can be readily secured, is elastic enough to correct and change imperfect rules. Especially is this argument pertinent in consideration of the proposed law of last winter, which met with the emphatic protest of the whole merchant marine interests of the country. The bill of last winter was a navy-revenue marine production. Its effect if made a law would have been to drive three-fourths of the engineers, worthy and trusted men, from their employment, and to reduce every steamer in speed, due to a lessened pressure of 10 per cent. in their boilers. Let us keep to the old law, ask the supervising inspectors to revise their rules, and with the aid of the present able secretary of the treasury we will do better than to employ professional tinkers to drive engineers from their employment and depreciate the value of every craft propelled by steam, as experience has shown might have been the case. There is no board connected with our government that has been more successful in practical results than this board, which a few disgruntled persons seek to legislate out of existance, and for this purpose subject the mercantile community to unnncessary annoyance if nothing more. Mr. Boyd very justly refers to insufficient pay in the whole service as an obstacle in the way of encouragement to competent officers, and nothing would be more deserved than an increase in the salaries of the present inspectors, as a reward for faithful ser vice in the past.

But though Mr. Boyd is not a politician to advise safety in appointments, he is an engineer of ability, and his suggestions have weight and importance professionally. Thus, his remarks about tests and test pieces, quality of material used etc., are good, as are also his remarks about the qualifications of engineers. As I have discussed already, his ideas of a proper examining board for inspectors, it is enough to add that it is not necessary to consult the navy, either in the matter of revision of the present rules or the promulgation of new ones, as he suggests. He advocates Senate bill 1755, the navy-revenue marine exploit, with modifications by his objectionable board. He has introduced into this last board, however, a consulting marine engineer who will find himself out of accord with the engineers of the United States navy and the United States revenue marine, and therefore of no use on the board. Mr. Boyd gets in another civilian as a "first-class nautical man," but then he might be a navy man as well. He adds to his paper a few well considered remarks about safety-valves and advisability of amending the rules governing them, and in conclusion he reads a letter to the inspection board signed by John F. Pankhurst and myself, relative to safety-valves on boilers in which we are interested. From this I take it that his sympathies and influence will be with us, for which we are under many obligations.

His paper professionally considered is a very able plea for revision of inspection rules and was so considered by the assembly of naval constructors and marine engineers before whom it was delivered.

Reference to Senate bill 1755 having proposed a reduction in the pressure of boilers of about 10 per cent., calls up a question in my mind as to the necessity of exceeding the steam pressure 50 per cent. by a hydrostatic test pressure. When the rule of 1871 was made the margin of 100 pounds was just 50 per cent., and at that time 100 pounds was an exceptional steam pressure for marine boilers. Now it is unreasonable and not at all necessary for safety. The hydrostatic should not exceed the steam pressure beyond a marginal limit of say 50 pounds.

Anyone familiar with the present careful construction of Scotch boilers and boilers of their class for marine use must agree in the opinion that a margin of 50 pounds reached without leakage would guarantee safety. This would raise the steam pressure in many instances to great advantage in engine economy and without sacrificing safety. I believe all engineers feel that hydrostatic pressure is damaging at very high limits, and many will agree with me in advantages that would promote security. The rule applying to water tube boilers makes the hydrostatic twice the steam pressure, but while this is entirely unnecessary it may be said that the tubulous type is able to endure this requirement, having no braces or stays to be strained.

MIERS CORYELL.

New York, Nov. 28, 1893.

Stirring Communication Relative to Free Ore.

EDITOR MARINE REVIEW:—I was glad to learn that the Lake Carriers' Association is taking action to protest against the removal of the duty on iron ore. The indirect evils of free trade are greater even than the direct, and no doubt the chief reason for including iron ore on the free list is to enable the British, by opening mines in Canada, to divert our vast ore trade to British ships. Their Fithian free ship bill, it is said, does not call for the entrance of foreign ships into our coasting trade, but this free ore is a menace to the whole shipping of the lakes. Iron ore is by far the largest item of freight on the great lakes, and more than twice the amount of all the shipments of farm products. Our fabulous mines in the Lake Superior region have created a fleet of 100 steel ships on our lakes, the most efficient and cheapest carriers in the world, and they have been the chief factor in building up a commerce on these lakes, which exceeds that of Liverpool and London combined. Like an all-powerful magnet they have concentrated around these lakes the best growth of the nation in population, commerce, agriculture, manufactures and wealth. Cleveland excels every other city in the nation in the building of steel merchant ships, and if our channels allowed, would build the war ships of the world.

The ingratitude, tne imbecility and the guilt of the men who would strike a blow at the iron industry and the shipping of the great lakes deserves the contempt and rebuke of all good men. It is time that the young men of the west bestirred themselves, unless they are prepared to see the American flag hauled down on both the land and sea and to accept as their heritage the enforced idleness and unjust wages of Europe. This is no time to give the order: Backward march. The deepening of the connecting channels of the great lakes by the United State government promises a speedy enlargement of both ships and shipping. Already Chicago has plans for a new deep harbor to meet the coming 20-foot Vikings. Our navigation laws have twice saved the nation in war and made us great in peace and they should be sacred.

Chicago, Nov. 21, 1893. F. B. NORTON.

The Fithian Snare.

Editor MARINE REVIEW:—My attention has been called to the Fithian free ship bill, and as every ship owner and ship builder in this country is deeply interested in this bill, I wish to call your attenion to it, and hope you will take it up in your columns and fight it to the bitter end. It is a snare, purporting to give American registry to ships built in any country free, to be used in the foreign trade only. No law, according to our constitution, could convey such a privilege—giving to ships the American flag, without giving with the flag all the privileges of our trade. This would ruin our coasting trade and lay it wide open to foreign ship owners, and its influence would also be felt to quite a large extent in our lake commerce, and we can not be too vigorous in our denunciations of this measure.

West Bay City, Mich., Nov. 27, 1893. F. W. WHEELER.

In General.

An English firm, Messrs. Scott and Mountain of Newcastle-on-Tyne, have introduced an electrical capstan. The capstan-head is of the usual form, and mounted on a vertical spindle running in a gun metal foot-step. The power is transmitted from the electric motor to the spindle by worm gearing. To avoid friction as much as possible the worm is made very truly and of case-hardened wrought iron. It is protected from dust by wrought iron covers, and works in a bath of oil. The electric motor is capable of developing 8 horse power when running at a speed of 1,000 revolutions a minute.

One of the principal reasons given by Chief Engineer Melville of the navy for the adoption of three screws in the Columbia when construction of that boat was begun, was the fact that it was extremely improbable that shafting of the great size necessary to transmit the enormous power (21,000 horse) to twin screws could be obtained in this country, either in reasonable time or with any guarantee as to its strength. A further consideration in favor of three screws was that either propeller could be disconnected from its engine and left free to revolve, thus retarding the speed of the ship but very slightly when she is propelled by two engines. In moderate cruising only one engine is necessary.

MARINE REVIEW.

DEVOTED TO THE LAKE MARINE AND KINDRED INTERESTS.

Published every Thursday at No. 516 Perry-Payne building, Cleveland, O.
Chicago office, (branch), No. 706 Phoenix building.

SUBSCRIPTION—$2.00 per year in advance. Single copies 10 cents each. Convenient binders sent, post paid, 75 cents. Advertising rates on application.

The books of the United States treasury department contain the names of 3,657 vessels, of1,183,582.55 gross tons register in the lake trade. The lakes have more steam vessels of 1,000 to 2,500 tons than the combined ownership of this class of vessels in all other sections of the country. The number of steam vessels of 1,000 to 2,500 tons on the lakes on June 30, 1892, was 321 and their aggregate gross tonnage 534,490.27; in all other parts of the country the number of this class of vessels was,on the same date, 217 and their gross tonnage 321,784.6. The classification of the entire lake fleet is as follows:

Class.	Number.	Gross. Tonnage.
Steam vessels	1,631	763,063.32
Sailing vessels	1,226	319,617.61
Canal boats	731	75,580 50
Barges	69	25,321.12
Total	3,657	1,183,582.55

Tonnage built on the lakes during the past five years, according to the reports of the United States commissioner of navigation, is as follows:

	Number.	Net Tonnage.
1888	222	101,102.87
1889	225	107,080.30
1890	218	108,515.00
1891	204	111,856.45
1892	169	45,168.98
Total	1,038	473,723.60

ST. MARY'S FALLS AND SUEZ CANAL TRAFFIC.

	St. Mary's Falls Canal.			Suez Canal.		
	1892.	1891.	1890.	1892.	1891.	1890.
No. vessel passages	12,580	10,191	10,557	3,559	4,207	3,389
Ton'ge, net regist'd	10,647,203	8,400,685	8,454,435	7,712,028	8,698,777	6,890,014
Days of navigation..	223	225	228	365	365	365

Entered at Cleveland Post Office as Second-class Mail Matter.

BUFFALO managers of the Lake Carriers' Association, who are in the majority on the legislative committee, have thought it advisable to have the association as an organization take no action in the matter of petitioning Congress relative to tariff on iron ore. The reason advanced has reference to dealings with Congress in the future, when, as the Buffalo members believe, it will be well to show that the association has never taken part in questions of a political nature. A vote of the general association would undoubtedly overrule this action of the legislative committee, but the vessel owners had, however, already given expression, as individuals, to their views on the proposed removal of the tariff. Protests have been sent from all of the leading lake cities, and now that it seems about certain that ore is to go onto the free list, another great draw-back to next season's carrying trade is presented. Additional uncertainty and inactivity must follow. The indications are that figures relative to iron ore on Lake Erie docks, which will be made up shortly, will show more unsold ore, both Bessemer and non-Bessemer, than there was at this time a year ago, notwithstanding the reduction of about 3,000,000 tons in the output. This means that only the largest mines will be worked during the winter, and these with reduced forces, so that the future of the vessel business, as viewed from present conditions, is even worse than it was before the opening of the season just closing, which has been the most disastrous in the history of lake business.

JAMES W. Ellsworth of Chicago and Calvin Morris of Cleveland, well known soft coal producers, have made large purchases of coal lands in West Virginia on the line of the Chesepeake & Ohio Railway. Large quantities of West Virginia coal from along the line of the Baltimore & Ohio are already being shipped to the north-west by lake, and if it is the intention to open up to lake business this new district on the Chesapeake & Ohio, the operators of the Pittsburg & Hocklng districts may look for active competition. The Chesapeake & Ohio, with its Vanderbilt connections, and under the direction of Mr. M. E. Ingalls, is a pushing company, and the great wealth of coal in West Virginia will be made to furnish it westward traffic, while its export business from Newport News continues to grow in competition with northern Atlantic ports.

CHICAGO vessel owners take little interest in the schemes proposed for regulating freight charges through concerted action on the part of all owners of "wild" carriers. It must be admitted that the vessel owners of other lake cities as well as Chicago have serious doubts about the possibility of a combination being effected, but the Cleveland men who want it succeeded in consolidating the old Lake Carriers' Association and Cleveland Vessel Owners' Association, although many were of the opinion that that combination could not be effected.

IN VIEW of the several accidents that have occurred during the past two seasons at the Lime-Kilns crossing, Detroit river, the suggestion of Mr. Wm. Livingstone, Jr., that the cut shou'd be widened from 440 to 600 feet, is worthy of consideration, and the subject will undoubtedly be taken up at the coming general meeting of the Lake Carriers' Association. As many as ten vessels have been known to meet in this cut at one time.

IN a paper on "Fast Ocean Steamships," in Cassier's Magazine for December, Dr. Francis Elgar, prominent English naval architect, draws an interesting comparison between the famous Great Eastern and the latest type of modern ocean steamer as exemplified in the Cunard liner Campania.

Capt. Edward A. Webb.

Edward A. Webb,brother of H. J. Webb of the firm of H. J. Webb & Co., ship owners and brokers of Cleveland, whose death was announced Monday, had been employed by his brother for a number of years and was probably as well posted in lake matters as any man in Cleveland. He was a well known figure in this old brokerage house, and vessel owners from all over the lakes who have met him in business dealings will hear of his death with sincere regrets. Little was ever said in the office of H. J. Webb & Co., that he did not hear, and a wonderful memory, coupled with a natural liking for the busine-s, served the firm and himself well on many occasions. In an office looking after the interests of many vessels in different parts of the lakes, questions of importance from shippers, owners and others, relative to the whereabouts of different craft, are asked at all times of the day, and "Ed" Webb, as he was familiarly called, was probably better able to answer such questions than any man in a like position in the numerous offices engaged in the same line of business. He will certainly be missed in the office of H. J. Webb & Co., and kindly remembered by a very large circle of friends among lake-faring men. He lost his wife from the same cause, typhoid-pneumonia, just three weeks previous to his own death. Entirely unassuming in manner, he was seldom, if ever, heard to speak of himself, but he had an army record of which any man might feel proud. He served all through the war of the rebellion, beginning as a private volunteer and coming out as a captain. He thus had full right to a title lavishly given to men in all branches of the lake business, but unheard of in connection with his name by many people who knew him well, until after his death.

Removal of Buoys—Buffalo Matters.

BUFFALO, N. Y., Nov. 29.—It is gratifying to learn that the old abuse of removing buoys from the shoals in November is to be attacked by the Lake Carriers' Association and it is rather exasperating to find the only stickler for the practice in Commander Green of this light house district. He stands his ground and refuses to accede in any way to the request to leave the buoys till navigation is closed. The other superintendents on the lakes readily agree to the requests. The end is not yet, however. It is to be hoped that now the question is put at direct issue that the lake interests will unite in driving out this antiquated practice. A single serious stranding would cost more than all the buoys in Commander Green's district are worth. As Capt. J. J. H. Brown remarks, if these buoys are ever needed it is when nights are longest and navigation most dangerous by reason of the low water of the fall season and the frequent high winds. If scantlings and brush will answer then they are good enough any day of the season. Commander Green's assertion made to the association that no disaster has occurred by reason of the removal of the buoys, should, if substantiated, secure the abandonment of buoys entirely. The vessel men should at once cite cases enough to drive him out of the position.

The legislative committee of the association is not posted on the new system of vertical stern range lights on vessels and asks for expert opinions before passing on them.

Buffalo vessel men are not always going to acquiesce in the condition of Niagara river. The government is spending considerable money in digging out a channel, but old captains who are vessel owners do not believe this will ever make a river running 10 miles an hour and full of boulders safe. One of them declares for the enlargement of Black Rock harbor into a full ship canal like the Sault, with a lock below the rapids. He cites the fact that for all the blasting there have, this season, been five vessels in dry dock here at once for repairs to injuries received by striking on Niagara river rocks, and he thinks the season's list will reach at least fifty. If this is not good reason for advocating a ship canal—especially when we have one all but finishing—nothing can be. Besides Buffalo is short of dock room and would add greatly to her frontage in that direction as soon as the river is made safe.

Weak Points in the Inspection Laws.

Editor MARINE REVIEW: The rapidly increasing use of water tube boilers and high pressures of steam on ship board has brought forcibly to the attention of engineers and owners two weak points in the inspection laws. These two points are the test pressure and the safety-valve area. When the laws were formulated 30 pounds was the common pressure; 100 pounds was considered high, while 150 pounds per square inch was not dreamed of.

The boiler which is licensed to carry 30 pounds is tested to 45 pounds hydrostic pressure, a margin of 15 pounds. To obtain a license for 180 pounds, a boiler must be strong enough to withstand tho straining of 270 pounds, a margin six times as great as that required for the commonest pressure when the laws were made. If the boiler is of the water tube type it must have twice this margin. This is a discrimnation against water tube boilers, and a hindrance to the use of high pressure steam.

To meet the requirements of the present day high pressures, 200 pounds and over, are absolutely indispensable. If 15 pounds was sufficient margin for the boiler of 1860, carrying 30 pounds, surely 50 pounds is enough margin for the boiler of 1894, whether it carries 300 pounds, 200 pounds or 100 pounds, and whether it be Scotch, plain cylinder or water tube in type. To comply with the law, however, it must be made for a Scotch boiler to carry 200 pounds 20 per cent., and for a water tube boiler at the same pressure 60 per cent. stronger than necessary. This means increased first cost, and what is more important increased weight. The importance of this latter item can not be overestimated, and is only appreciated by those who have to contrive to get one ton of machinery to do the work of two. The British navy long ago gave up the custom of increasing the margin required with increasing pressure allowed and adopted 90 pounds as the margin for all pressure. This is twice as much as is necessary.

The second weak point is the safety-valve area. The present law requires 1 square inch of area for each 3 square feet of grate area be the pressure, or quantity of water contained in the boiler, or amount of coal burned, what they may. One boiler may make four times as much steam as another, but if the grate area is the same, the same valve does for both. Here again the laws discriminate against the water tube boiler, and again are hostile to high pressure steam. A water tube boiler built to carry 250 pounds pressure, capable of making 90 pounds of steam per minute, contains 2100 pounds of water, and is required to have 10 square inches of safety-valve area—three times the area of the steam pipe. This would discharge at the allowed pressure 7800 pounds of steam per minute, or at the rate of emptying the boiler in seventeen seconds—an explosion in effect and in fact. No human agency could handle a fire quickly enough to save that boiler from destruction if such a valve ever fully opened. A danger-valve this, not a safety-valve!

Compare with this a Scotch boiler built by the same firm who built the above mentioned water tube boiler. It is allowed 160 pounds steam, evaporates 200 pounds of water per minute, contains 30,000 pounds of water and steam, and is required to have a safety-valve of 20 square inches area. This valve would discharge a little less than 10,000 pounds of steam per minute, or at the rate of emptying the boiler in a little over three minutes. Had thts same boiler been built for 30 pounds pressure, the safety-valve would have been the same. At 30 pounds this area would discharge at the rate of emptying the boiler in about twenty minutes—more than seventy times as long as for the water tube boiler above referred to.

Between these wide and unreasonable extremes there is a reasonable mean. A five-minute rate is rational and would be a good basis for a new law, which should take cognizance of the fact that steam at 300 pounds pressure will crawl out of a hole into the atmosphere more than ten times as fast as steam at 30 pounds; that it takes a larger hole at the same pressure to discharge twenty tons of water than for as many hundred weight, and that a boiler evaporating 125 pounds of water per square foot of grate does not need so large a valve as one making 400 pounds of steam for the same grate area. A simple and practical rule to meet these requirements is easily deduced. The area must be enough to discharge in five minutes an amount of steam equal in weight to all steam and water contained in the boiler, and in addition all feed water which may have been pumped into the boiler in five minutes. The amount of feed water may with fairness be assumed to be equal to the maximum evaporation. Therefore the discharge per minute should be one-fifth of the total water in the boiler plus maximum evaporation per minute. The requisite area in square inches of the opening will be found by dividing the quantity to be discharged per minute by the amount discharged per square inch per minute.

Then for any boiler the area in square inches is equal to one-fifth the total weight, in pounds, of water and steam contained in the boiler plus the maximum evaporation in pounds per minute divided by the number of pounds discharged per minute, per square inch at the allowed pressure. We find by careful calculation that the discharge of steam in pounds per minute, per square inch of opening, is equal to about three times the pressure of the steam in pounds per square inch above the atmosphere, guage pressure. The exact amount is a trifle less than three times for pressure below 100 pounds and a little over for pressure above 200 pounds. The error is too small to effect the result appreciably.

Using this expression for the discharge over area will be one-fifth of the total water and steam in the boiler plus maximum evaporation per minute divided by three times the guage pressure. Or putting

W = total steam and water in boiler in pounds,
E = maximum evaporation in pounds per minute,
P = guage pressure,
A = safety-valve area in square inches.

$$A = \frac{(1\text{-}5\ W) + E}{3\ P}$$

A formula which gives the same measure of safety for all types and condition of boiler.

Stamford, Conn. '86 S.

Iron Mining Matters.

Vermillion range shipments are at an end, and the aggregate for the season from Two Harbors, the shipping port for that range, is 902,355 gross tons, of which 817,799 tons was from the Vermillion and 84,555 tons from the Missabe. The Vermillion shipments are in excess of any previous year excepting last year. The season's shipments from the several Vermillion and Missabe range mines moving ore through Two Harbors were as follows: Chandler, 435,368 gross tons; Minnesota, 369,461; Zenith, 12,969; Cincinnati, 10,059; Canton, 24,366; Franklin, 46,619; Hale, 3,510.

The Duluth stock exchange is again quoting prices on shares of Missabe range companies. Among bid prices noted are the following: Biwabik $21, Cincinnati $31, Great Northern $3, Mountain Iron $50, Missabe Mountain $13.50, Shaw $3, Adams $7, Missabe Chief $1.75, Ohio $5, Towanda $1.50.

The Lake Superior Iron Company, a Missabe range corporation, is said to have declared a dividend of $30,000 on its capital stock, a portion of the proceeds from the sale of the lease of properties to the New York and Missabe Iron Company.

Trade Notes.

The American Shipmasters' Association, publishers of the Record of American and Foreign Shipping, classed last week the British schooner Eventide, American schooner Garret P. Wright and American three-masted schooner James H. Dudley.

As indicated by an advertisment elsewhere in this issue, DeGrauw, Aymar & Co. of New York, general agents for the Tyzack stockless anchor described in the REVIEW a few weeks ago, are now prepared take orders and urge the adoption of this anchor on the lakes. The Upson-Walton company of Cleveland, George B. Carpenter & Co. of Chicago and H. D. Edwards & Co. of Detroit are lake agents.

Inland Navigation In France, England and Germany.

Mr. A. V. Gude, president of the Engineering Association of the South, has given considerable attention to the transportation question in this country, and was a delegate to the meeting of the International Congress on Inland Navigation held in Paris. In an address delivered recently before the southern association in the Relative Use and Importance of Railways and Waterways he said:

"No other country has so perfect and beautiful a system of inland navigation as France, and the engineer who wants to study that branch of our profession can learn more there than anywhere else. All the principal rivers, heading in the interior and finding their way to the ocean in all directions of the compass, have, by means of movable dams and locks, been made navigable nearly to their sources; and have, by means of canals, been connected with each other, so as to enable you to start your boat at the mouth of any one of them, and, passing through the center of the country, land at the mouth of any of the others. And the traffic on some of them, especially the Seine and its tributaries, is very considerable. To an American, accustomed to the sight of rivers in his own country, with their banks generally in the same condition as when the Indian paddled his canoe on their waters, it is astonishing to see how completely nature, in the French rivers, has been subdued by man, made to do his work and to be subject to his control. To be sure, the task of controlling the streams of France, with the much slighter annual rainfall and smaller difference between high and low water mark, is comparatively an easy one; but great credit is due to the French engineers for the talent and skill they have displayed in solving the problem. By means of the movable dams, first invented by them, and now brought to a high degree of perfection, they have taught us how to store, in a river, the water needed for navigation during the dry season of the year, without placing any considerable obstruction in the way of the waters during a freshet, and thus making the stream navigable at all times, without causing overflow to the banks.

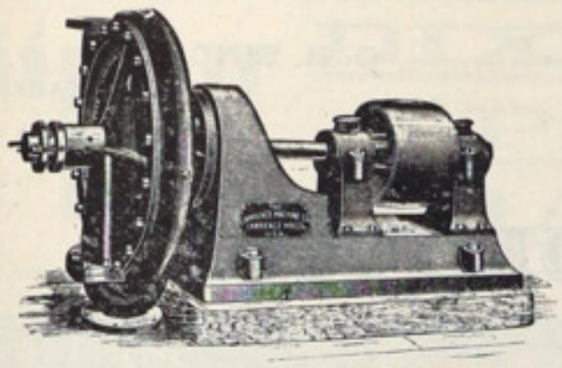
"In the United Kingdom, with an area of 121,656 square miles, and a population in 1890 of 38,740,000, there were 19,943 miles of railroad, or about 515-1000 of a mile to each 1,000 inhabitants, and 3,813 miles of inland waterways. The canals belong to private persons, or corporations. Very few canals have been built during the last fifty years, and in their struggle with the railroads many of them seem to have difficulty in keeping alive. The canals, undoubtedly, play an important part in carrying coal and minerals; but they are barely holding their own, while the annual increase in business of their rivals—the railroads—is very great.

"France, with an area of 204,000 square miles, has about 38,427,000 inhabitants. In 1891 there were 19,900 miles of railroads, 518-1000 of a mile to each 1,000 inhabitants—almost exactly the same proportion as in the United Kingdom. The number of tons of freight moved by rail in 1887 was 81,000,000 or 20.11 tons to each inhabitant. The total length of all waterways is 10,385 miles, of which about one-third is reported to be in good and efficient condition, one-third passable, and one-third practically out of use for want of repairs or business. The waterways carry about 24 per cent. and the railroads the remaining 76 per cent. of the freight annually moved in France. All the railroads, and nearly all of the canals, belong to the state. The railroads are divided into seven great systems. Only one of them—and that the least important, Paris-Orleans—is operated by the government; the others are leased for long terms of years to private corporations. But they are kept under government supervision, and the freight and passenger rates are so low that the government has to pay the companies large subsidies. Everybody seems to agree that it is neither profitable, nor otherwise expedient, for the government to operate the roads.

"With a population of 62,622,000, the United States had in 1890, 167,741 miles of railroads, or 2.68 miles to every 1,000 inhabitants—more than five times as great a proportion as in France or the United Kingdom. According to Poor's Manual, the railroads carried, during the same year, 701,000,000 tons of freight, which is equal to 11.2 tons for each inhabitant, or 5.3 times as much as the railroads carried for each inhabitant of France in that year. Col. E. Merrill, in a report to the House of Representatives of the Fifty-first Congress, first session, gives a detailed statement of all the canals and canalized rivers in the United States. According to it, the total length of them all was: Canals, 2,278 miles; canalized rivers, 1,070; total, 3,348. Of these, 576.9 miles belong to private parties, 386 to railroad companies, the balance to the federal government, or to the states in which they are located. Unfortunately we have practically no statistics of the traffic on them and on the navigable rivers. The importance of the principal inland waterways—the lakes and the Mississippi river system—is very great, not only on account of the vast amount of freight carried on them, at extremely low rates, but also because, owing to the competition with them, the railroads have been compelled to make great efforts to get their share of the business. But, though we have no statistics to prove it, there can be no doubt about it, that the traffic on most of our canals and navigable rivers has not grown in the last decade or two; their formidable rivals, the railroads, having absorbed most of the business.

Following these statistics Mr. Gude asks the question: Have the canals, as a means of transportation outlived their usefulness? "The experience of England," he says, "aside from its exceptional Manchester ship canal, would seem to lead us towards answering this question in the affirmative. But the British islands, surrounded on all sides by the ocean and deeply indented with navigable estuaries, has unusual facilities for cheap transportation by water, independent of any artificial ways, and whatever fate the future may have in store for the British canals, general conclusions, applicable to other countries, can hardly be drawn from them. What the future has in store for us can better be predicted by observing what is taking place in France. There we have a great, beautiful, compact country of many divers resources, inhabited by a high-spirited, gifted people, who for many centuries have been taking the lead amongst the nations of continental Europe, and always will be of a peculiar charm to visitors and to students of history. In order to carry out their industries economically, cheap transportation of heavy articles—such as coal, minerals and wood—is necessary; and that can be done in no other way as well as by waterways. The policy of the French government, that the canals must be maintained, and new ones built—where needed—is well established and undisputed by all political parties. At present, in our own country, the condition of inland navigation resembles that of England more than of France. With the exception of the two great natural systems of waterway, the lakes and the Mississippi, the canals and navigable rivers play but an insignificant part, compared with the railroads. But, as our population grows larger and our natural resources, in proportion to the number of inhabitants, grow less bountiful, we will have to practice greater economy in our industries. In the transportation of heavy articles, speed will be of less importance than cheapness, and we will have many systems of inland navigation to compete successfully with the railroads, in carrying heavy and bulky articles of freight."

Mr. W. S. Doran, Chicago sales manager for Henry R. Worthington, has resigned his position with the big pump manufacturing establishment, to become manager of the John Reilly Supply and Repair Company of Nos. 229 and 230 West Street, New York. Mr. Doran will leave Chicago Dec. 18 to take up his new charge. He says that his love for salt water was too strong to permit of his staying any longer in the west.



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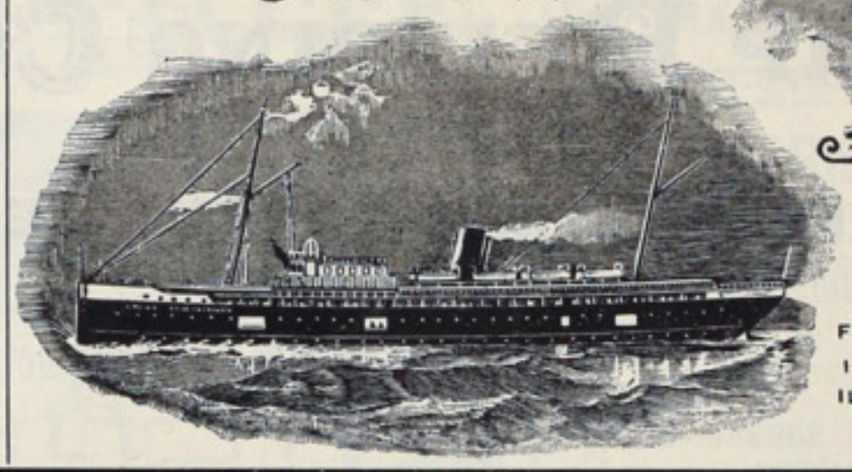

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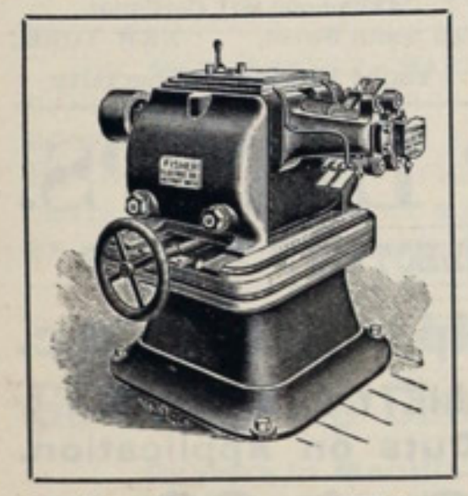

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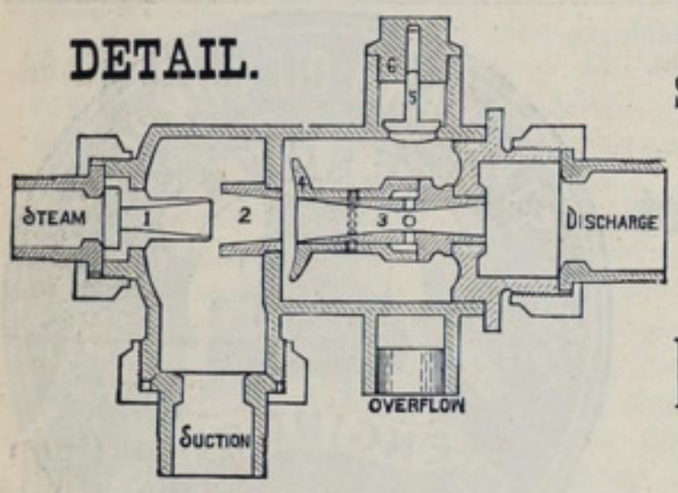

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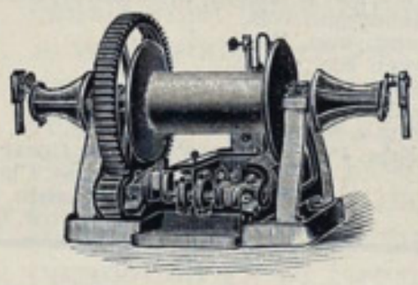

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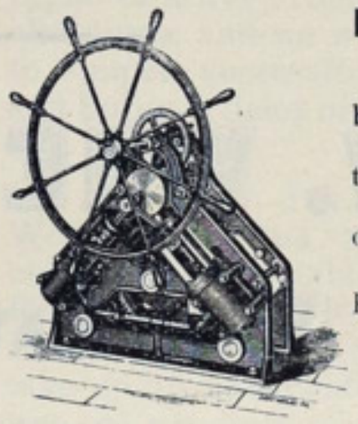

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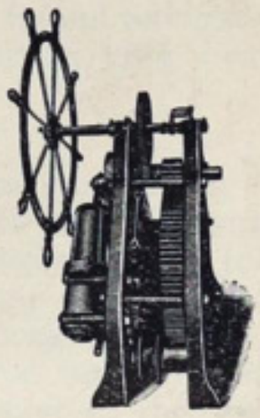

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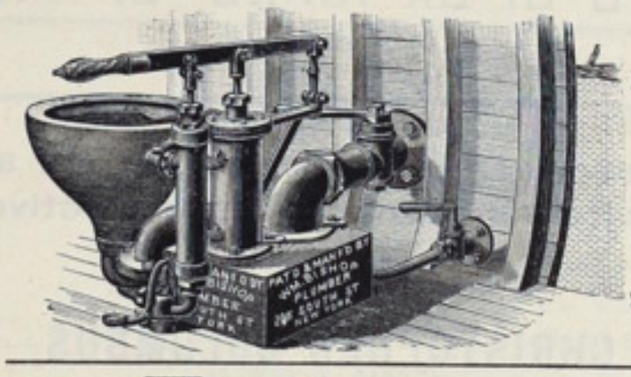

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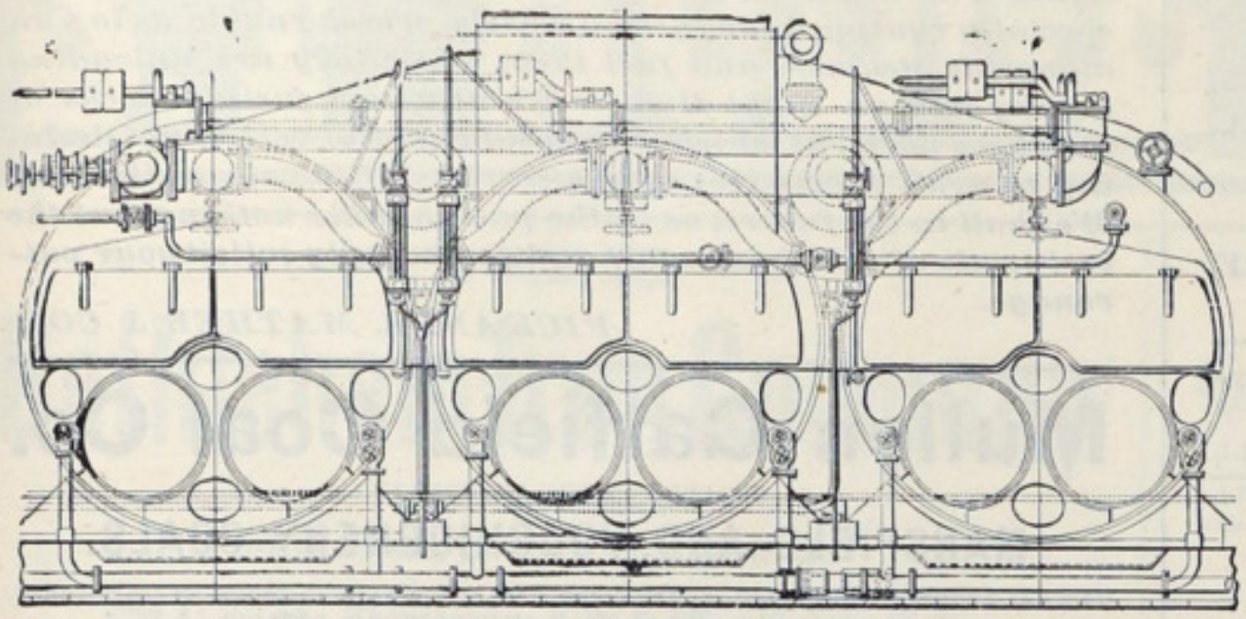

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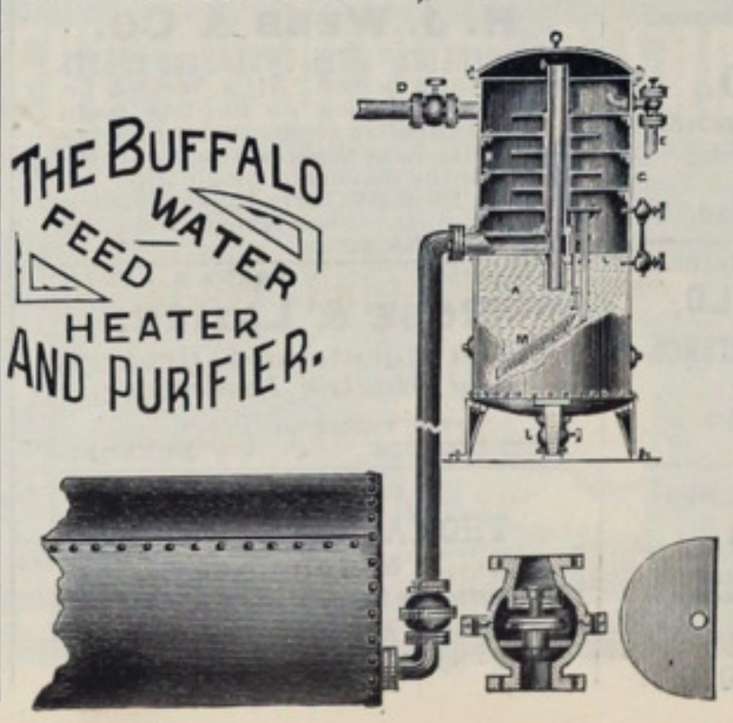

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C.—Feed pipe to boiler.
D.—Steam pipe.
E.—Water supply pipe.
F.—Check valve.
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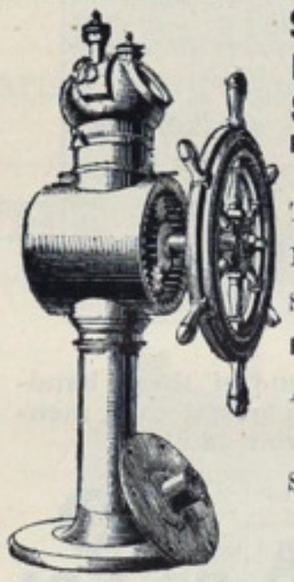

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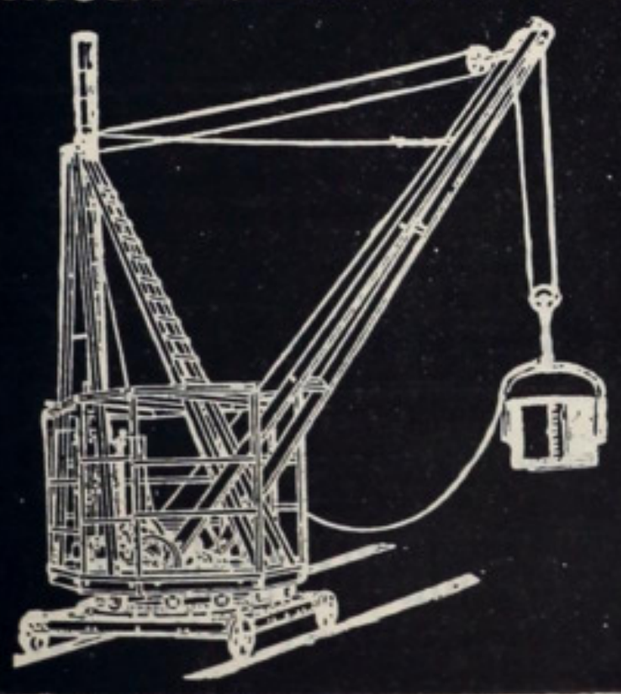

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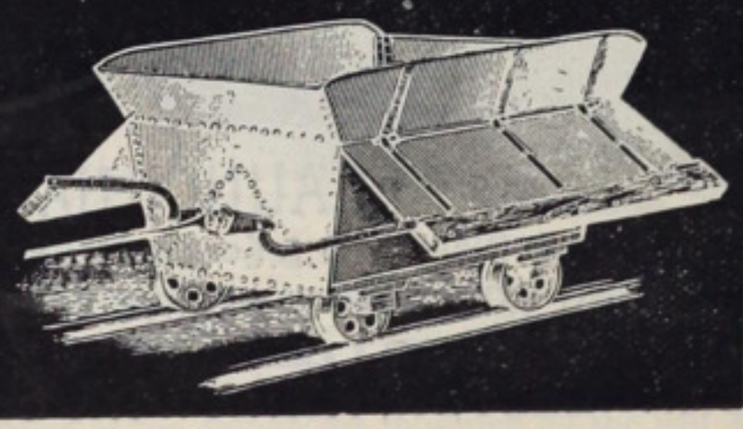

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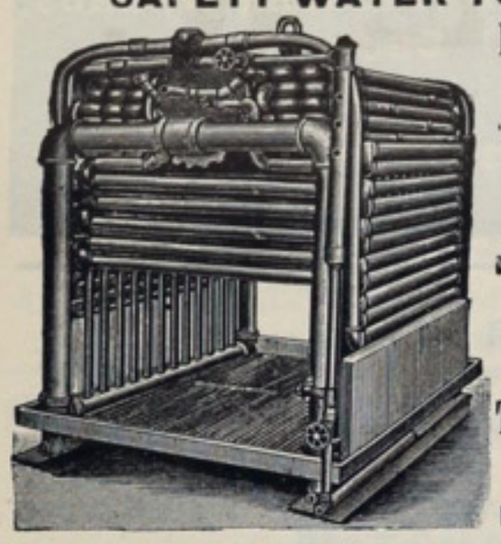

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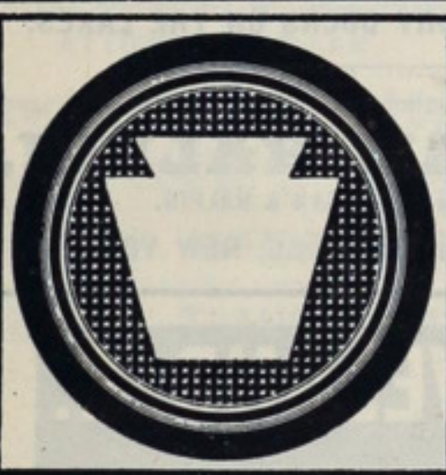

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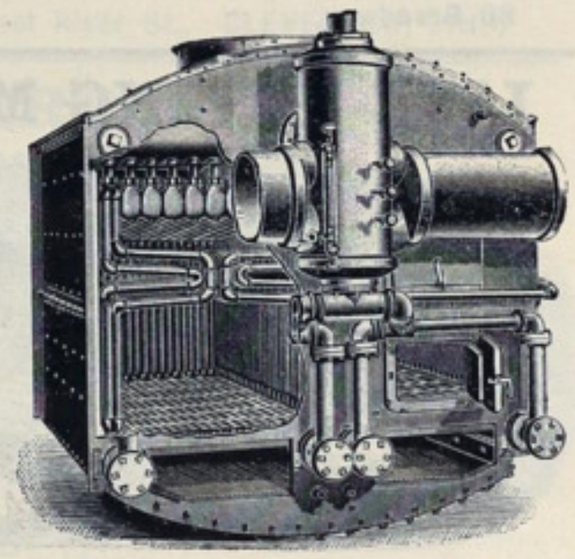

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